III.—*On the Circulation of the Blood in the Spiders of the Genus* Lycosa. By Edouard Claparède*.

The circulation of the blood in the Arachnida has already been the subject of profound investigations. Those of Newport on the circulatory organs of the Scorpion† in particular enjoy a credit to which they are entitled in the highest degree. They have been completed and at the same time corrected in some points of detail by Blanchard. The latter has also bestowed on science some splendid investigations of the circulatory organs of other sections of the Arachnida. He has in particular devoted a considerable part of his Memoirs to a Spider of the genus *Mygale*. At this moment he is publishing some magnificent plates of the anatomy of the Arachnida‡; and although the text relating to the Spiders has not yet appeared, it is easy to see, from the plates already published, the results at which he has arrived.

It will be seen that on more than one point I cannot agree with M. Blanchard; but none the less do I accord my tribute of admiration to the labours of that learned anatomist, and this without any reservation. M. Blanchard has resorted to the method of injection already practised by Dugès, Newport, and others. I believe that he has obtained from it everything that it can be made to furnish. By its means he has recognized with perfect accuracy all the principal vascular trunks; but nevertheless this method has not always informed him with perfect certainty of the direction of the circulation of the blood in the vessels. Moreover it has frequently spread for him a snare, in which so many anatomists have allowed themselves to be taken under other circumstances. M. Blanchard has too often thought that he found sanguiferous networks, when he had under his eyes only the meshes of an artificial net hollowed out by the injected material in the delicate tissues. Once more he has shown how necessary it is that the method of injections should be submitted to a severe check, if we would not reproduce the exaggerated discredit into which it has fallen in the eyes of more anatomists than one.

I have followed quite a different course. I have endeavoured to procure young Spiders so transparent as to allow the course of the blood to be investigated in its full activity. The most favourable object that I have hitherto met with is the *Lycosa saccata*, Hahn. The females of this species carry their ovigerous sac applied to the posterior part of their abdomen. The young

* Translated by W. S. Dallas, F.L.S., from the 'Annales des Sciences Naturelles,' Nov. 1864, p. 259.

† Phil. Trans. 1843, part 2, p. 213.

‡ L'Organisation du Règne Animal, par Emile Blanchard: Arachnides, livr. 1–16.

individuals already hatched, but still contained in this sac, were employed by me in my researches. It will not, perhaps, be useless to those who may wish to repeat my observations, to remark that the young *Lycosæ*, like most of the other Spiders, undergo a moult in the interior of the ovigerous sac. The individuals which have already undergone this moult, or in which it is approaching, are unfit for observation. The former bristle with opake hairs; and the latter already present, beneath the integument which they are about to throw off, the hairs characteristic of the following phase. It is therefore immediately after hatching, and before the preparations for the moult, that the *Lycosæ* must be studied, if we wish distinctly to recognize their circulatory apparatus. Even at this period, the young individuals possess a great resemblance to the adult. All the organs are formed, with the exception of the abdominal portion of the digestive tube, with its appendages, and the reproductive organs. The intestine and the glands which are dependent on it (liver, urinary glands) are represented by a strongly refractive mass of a brownish-yellow colour—the unassimilated residue of the vitelline emulsion which formerly filled the membrane of the egg. In the cephalothorax we also find a residue of the vitellus enclosed in an annular stomach and its cæcal diverticula.

The heart, or dorsal vessel, is situated on the median line, exactly following the curve of the dorsal surface. Seen in profile, it seems to describe nearly a semicircle. It presents its maximum breadth in the immediate vicinity of the abdominal peduncle, and from this point it gradually diminishes in calibre to its posterior extremity. Its transverse section is not circular, but elliptical, or, rather, reniform, the greater convexity of this section being turned upwards. At different parts the heart presents lateral dilatations, or, rather, diverticula, arranged in pairs. These diverticula are of the form of wide cones, of which the base is continued into the wall of the heart. There are three pairs of them, and the last are much less developed than the preceding ones. Sometimes I have fancied that I could see a fourth, still further back; but with regard to this I have not been able to arrive at certainty. At the level of each pair of diverticula there is a pair of those orifices like button-holes which were first discovered by Strauss in Insects, and which so many anatomists have since detected in the most diverse forms of Arthropoda. I shall retain for them the name of *venous orifices*, rather than that of *atrioventricular apertures*, which has often been given to them. These apertures are not exactly transverse, but oblique, their dorsal or inner angle being directed a little forwards, and their outer angle a little backwards. This latter advances slightly beyond the limits of the heart properly so

called, and is cut into the back of the base of the conical diverticula which I have just described. The orifices of the foremost pair are the largest, the next are a little smaller, and those of the third pair the least of all. All these pairs serve for the afflux of the blood into the heart at the moment of diastole. Under the microscope, the blood-globules are seen to engulf themselves in them at each dilatation.

At this period of life the heart is not divided into several chambers by internal folds or valves; but I cannot say whether this is the case also in the adult. I know that Newport and Blanchard have found these valves in the heart of the Scorpion, and I have no doubt that their observations are perfectly correct. But nothing of the kind exists in the young *Lycosæ*. The venous orifices, which gape widely during diastole, close during systole, and thus prevent the blood which they have allowed to pass from returning. This closing seems to be effected by the action of the muscular fibres which form the margins of the orifice. These fibres present one large nucleus or an agglomeration of nuclei towards the middle of the margins of each orifice. At the moment of the closure of the orifice (which immediately precedes the systole of the heart), the nuclei of the opposite margins of each orifice are seen to apply themselves energetically to each other. Moreover the entire wall of the heart is beset with nuclei, which, however, are a little less apparent than the above. These are no doubt the nuclei of muscular cells, the presence of which is indicated by the transverse striæ of the wall of the heart.

The heart receives the blood only through the six orifices which I have just described, at least unless there is a fourth pair of such apertures. Indeed M. Blanchard, who represents the heart in *Mygale* as simply cylindrical, ascribes to it four pairs of atrioventricular apertures. But the place where this fourth pair of apertures should be found in the *Lycosæ* is generally so well masked by vitelline granules that I have never succeeded in seeing it.

Let us now consider the issues through which the blood escapes from the heart to take its way to the organs. In the first place we find the thoracic aorta originating from the anterior extremity of the heart, as has been recognized by all the anatomists who have investigated this subject. But it is only a small portion of the blood that is driven by the heart into this vessel. When the young Spider is placed so as to be seen in profile, we perceive that it is only the *cul-de-sac* comprised between the first pair of orifices and the origin of the aorta that sends its blood into that vessel. The pneumocardiac current, which penetrates into the heart through these orifices, divides

immediately into two branches, one of which bends forwards to reach the aorta, whilst the other curves backwards so as to continue its course as far as the posterior extremity of the heart, receiving in its passage affluents from the other apertures. It is thus only the shortest portion of the heart that drives the blood in the same direction as the heart of the other Arthropoda. It is true that, if this portion is short, it is at the same time the widest part of the dorsal vessel.

The posterior part of the dorsal vessel is simply tubular, and may bear the name of the *posterior* or *caudal aorta*. It penetrates into the apex of the abdomen, which may be called the *pygidium*, where it is found gaping widely into a lacuna which occupies this pygidium and the base of the spinners. The form of this orifice is oval; under the microscope it is seen to be constantly giving passage to a large stream of blood which pours into the lacuna of the pygidium.

No doubt these are not the only apertures by which the blood quits the heart. I have described above the conical processes or diverticula which this viscus presents at the level of each pair of venous apertures. These processes are prolonged into whitish bands, which turn round the sides of the body, and descend towards the ventral region of the abdomen. I regard these bands as arteries; but I must admit that, as these organs are only of small diameter, and repose upon a somewhat opake vitelline mass, I have never succeeded in seeing blood-globules moving in their interior. Hence I cannot arrive at complete certainty upon this point. I am aware that, according to M. Pappenheim*, the heart in Spiders does not present any trace of lateral vessels, and gives origin to vascular trunks only at its two extremities; but I cannot attach very great importance to the assertions of this anatomist, seeing that he represents the heart in Spiders as enclosed in a pericardium which presents no aperture. He thus appears implicitly to assume that one extremity of the heart is venous and the other arterial, and seems to have had no knowledge of the lateral orifices. This notion is radically wrong; and M. Pappenheim may equally well have deceived himself with regard to lateral arteries. I would rather rely upon the old but skilful dissections of Treviranus, who found lateral arteries in the heart of *Tegenaria domestica*; moreover it would be an arrangement exactly conformable to that described by Newport in the Scorpions.

It is true that M. Blanchard, resuming a theory which was only doubtfully put forward by Dugès†, regards these organs

* Comptes Rendus, 1848, tome xxvii. p. 159.

† Additions au Mémoire de M. Dugès sur les Araignées (Ann. Sc. Nat.

as pneumocardiac vessels conducting the blood from the respiratory organs to the pericardium, and consequently indirectly to the lateral orifices of the heart. But this opinion is decidedly false, seeing that these vessels directly reach the heart. Their cardiac origins, which we have described as forming lateral diverticula of the heart, have so little to do with the pericardium that the lateral slits are in part cut in their base. If, therefore, these organs are vessels and not ligaments, they are arteries and not veins. I hesitate the less to pronounce in favour of the old opinion of Treviranus*, because the existence of lateral arteries of the heart is a *desideratum*—the quantity of blood issuing through the posterior orifice of the heart being evidently far inferior to that which traverses the anterior regions of that organ.

The heart and its lateral arteries are the sole arterial vessels of the abdomen. The blood is poured out by them into the interorganal lacunæ, and bathes all the organs. The heart itself is bathed by a mass of blood which travels in an opposite direction to that contained in the heart—that is to say, from behind forward. This liquid is drawn in through the lateral orifices at each diastole of the heart. I cannot say whether this pericardiac lacuna is the cavity of a pericardium. I have never seen anything that appeared to indicate the presence of such an organ, but I may say that I have rather been led to doubt its existence. The integument of the young Spider presents several tergal arches—vague indications of a dorsal segmentation. Their number appears to be six, or perhaps seven. At each of them is a muscular ligament attached to the heart, no doubt corresponding to the muscles called the *wings of the heart* in Insects. These muscles appear to be attached, on the one hand, to the integuments, and, on the other, to the *wall of the heart itself*. There is nothing to indicate the existence of a pericardium; moreover it is a question of secondary importance to ascertain whether the blood is here contained in an interorganal lacuna or in a pericardium. The important fact (and this is beyond all dispute) is, that the heart is bathed in all parts by a mass of blood contained in a space which I shall provisionally name the *pericardiac lacuna*, without, however, attaching any importance to this denomination. A fact which is equally important to note is, that the origins of the lateral arteries to which I have given the name of *lateral diverticula* of the heart *are bathed externally by the blood* of this lacuna. Now this could not take

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1836, tome vi. p. 355). See also the 'Règne Animal,' édition illustrée: Arachnides, pl. 3.

* Ueber den inneren Bau der Arachniden, 1812, p. 28.

place if the views of M. Blanchard with regard to his supposed pneumocardiac vessels and the pericardium were well founded.

It is true that there are, in some degree, pneumocardiac vessels, and even a kind of pulmonary veins. These vessels, however, have the following peculiarities:—they are very wide, they never communicate directly with the arteries or with the heart, and both their extremities open into interorganal lacunæ. I shall call them *sinuses*, desiring to indicate thereby that they incontestably possess proper walls.

I shall describe these sinuses, commencing with those whose office it is to conduct the blood to the respiratory organs, and concluding with those which convey the oxygenated blood to the heart. We have seen that the posterior region of the body presents a very large lacuna, occupying especially the pygidium and the spinners. The blood which fills this lacuna passes at the ventral part of the abdomen into two sinuses—the longitudinal sinuses of the abdomen—which convey it forward. These two sinuses are nearly parallel to each other, and their walls are of a silky whiteness when they are seen by incident light. The blood flows in them constantly from behind forwards. These two sinuses occupy the whole length of the abdomen, and unite in a median sinus at its base. In their anterior portion, however, these sinuses present a circulation exactly opposite to that just described. The blood there always travels from before backward: this is because at this part they carry the blood of the thoracic lacunæ. In reality these longitudinal sinuses of the abdomen are composed of two parts, which, anatomically, form the direct continuation the one of the other, but which nevertheless convey the blood in opposite directions. The point of junction of these two parts is the inner and posterior angle of the lung; here each of the longitudinal sinuses gives origin to a transverse process, which may be called the posterior pulmonary sinus, as it borders the posterior margin of the lung. The two currents of the longitudinal sinus flow into this transverse sinus, in which they mix together; on arriving at the outer and posterior angle of the lung, the stream of blood changes its direction, almost at a right angle, to form what may be called the lateral pulmonary sinus, which follows the outer margin of the lung. This sinus then bends towards the upper part of the abdomen to open into the pericardiac lacuna, nearly at the level of the first pair of lateral orifices. Most of the blood-globules pass from the posterior to the lateral pulmonary sinus by describing the angle that I have just described; some, however, cut this angle by gliding obliquely over the lung. This proves that the posterior and lateral pulmonary sinuses are only the margins of a large sinus in which the entire lung is immersed.

The blood-globules never penetrate between the leaflets of the respiratory organ; and, no doubt, it is the plasma of the blood that is endowed with the function of absorbing oxygen and emitting carbonic acid.

In consequence of the arrangement of sinuses which I have just described, the greater part of the blood passes through the lung before returning to the heart. This is the case with all the venous blood of the cephalothorax arriving by the anterior part of the median longitudinal sinuses; it is also the case with a great part of the blood returning from the pygidian lacuna through the posterior part of these sinuses. It is possible that the quantity of abdominal blood arriving at the lung may be still greater; in fact each longitudinal sinus of the abdomen receives, about the middle of its length, a transverse sinus, which probably brings to it a new affluent. Nevertheless I have never been able to ascertain the direction of the circulation in this sinus; it may be that it conveys non-oxygenated blood derived from the longitudinal sinus into the pericardiac lacuna. However this may be, it seems probable that a great part or even nearly the whole of the blood of the pericardiac lacuna behind the first pair of lateral orifices has not passed through the lungs. Indeed, it must not be forgotten that the blood moves from behind forwards in this lacuna. All the blood that returns from the lungs penetrates into the heart through the first pair of lateral orifices.

The longitudinal sinuses of the abdomen, in which the blood is seen in rapid motion, appear to have hitherto escaped the notice of nearly all observers. It is probable, however, that they might be demonstrated even by the scalpel in the larger species. Their position, indeed, is easily determined; they repose exactly upon the longitudinal muscular bands which Treviranus* was the first to indicate, which were subsequently described by Brandt† as *tendons*, and which recent anatomists, M. Blanchard included, have seen like their predecessors. Dugès alone seems to have had some knowledge of these sinuses. He says ‡: "In the common *Epeïra* of Walckenaer the skin of the abdomen is very transparent and slightly coloured soon after a moult, and then the whole abdomen may be seen banded transversely and obliquely by very superficial vascular ramifications, starting from the whole length of the lateral and superior margins of the heart and from its posterior extremity. They are seen less distinctly in the *Epeïra diadema*. These innumerable vessels,

* *Loc. cit.* p. 45.

† Recherches sur l'Anatomie des Araignées (Ann. Sc. Nat. 2e sér. 1840, tome xiii. p. 180.

‡ *Loc. cit.* p. 359.

too delicate and too pellucid to be dissected, curve downwards and forwards towards the lungs; they become enlarged and apparently confounded together in proportion as they approach the latter, so as to constitute a lacuna parallel to the large longitudinal muscles which occupy the lower region of the abdomen. This space is transparent and filled with fluid in *Pholcus*"*. This description is in perfect accordance with what we have said of the *Lycosæ*, except as regards "the innumerable vessels." Dugès, however, does not appear to have seen the blood in circulation.

There was a time when M. Blanchard did not go so far as Dugès in the multiplication of the blood-vessels in the Arachnida. He said, at this period †, "What appears to be remarkable in the vascular system of *Epeïra* is the small number of ramifications presented by the arteries; for my investigations and experiments have been repeated upon a very large number of individuals, and always with success; I think, therefore, that few details can have escaped me." The opinions of the learned anatomist have become greatly modified since that time. At any rate, M. Blanchard then represented, in *Epeïra diadema*, two vessels nearly in the position of the longitudinal sinuses which we have described; but he regarded them as pneumocardiac vessels destined to convey the oxygenated blood to the posterior part of the heart. He therefore assumed that the movement of the blood took place in these vessels in a direction precisely opposite to the real direction of this movement. Far be it from me to reproach him for having been mistaken on this point; for the method of injections alone could never solve the question of the direction of the movement.

Hitherto I have only considered the abdominal circulation; but I shall now speak of that of the cephalothorax. The arterial portion of this circulation is now well known, thanks to the investigations of Dugès, and especially of M. Blanchard. The ramifications of the aorta in the *Lycosa saccata* are nearly identical with those figured by M. Blanchard in *Mygale avicularia*. This large vessel traverses the abdominal peduncle above the digestive canal, follows an ascending direction beneath the posterior dorsal region of the cephalothorax, and penetrates the stomach-ring. At this point it divides into two secondary aortas, which soon curve downwards so as to form a crook. Immediately beyond the crook, each secondary aorta spreads out like a duck's foot, and gives origin to several branches. These are, first, the ophthalmic artery, then the four pedal arteries, the artery of the deutognath, and that of the protognath. Each of

* This remark with regard to the *Pholci* is perfectly correct.

† Ann. Sc. Nat. 3e sér. 1849, tome xii. p. 324.

the six latter, or at least five of them (the protognathic artery excepted), gives origin in its course to a branch which is directed towards the ventral region, and empties itself into one of the lacunæ which we shall shortly describe under the name of *transverse sternal lacunæ*. Lastly, the artery of the protognath gives origin to a branch directed upwards and inwards, and which discharges itself into a blood-reservoir which we denominate the *median tergal lacuna*.

These are all the vessels of the cephalothorax. M. Blanchard also describes, under the name of *posterior aorta*, a delicate median artery originating by one root from each secondary aorta, and returning backward into the abdomen. I have not succeeded in seeing this, although I will not for that reason dispute its existence. The *Lycosæ* are certainly very unfavourable for the recognition of a vessel so placed. On the other hand, M. Blanchard describes neither the sternal arteries nor the tergal branch of the artery of the protognath which I have pointed out. I must say, however, that their investigation is not free from difficulties, and that for a long time I was doubtful of their existence.

All these arterial vessels are very clearly bounded by evident walls, and all present the phenomenon of rhythmic pulsations synchronous with those of the heart. These pulsations, the observation of which is far more easy than that of the passage of the blood-corpuscles in the calibre of the vessels, greatly facilitates the study of the arterial system. The first fact that strikes the eyes of the observer, whether he examines the animal from its lower or from its dorsal surface, is the existence of two perfectly circular clear spots—one to the right, the other to the left, of the median line. These spots present a very evident alternate movement of diastole and systole; they represent the transverse section of the aortic crooks by the focal plane of the microscope. It may indeed be easily ascertained, by an alternate ascending and descending movement of the tube of the microscope, that these circles are the expression of vertical tubes in which the blood moves from above downwards.

Reserving for future consideration the circulation of the blood in the extremities, let us examine the course of the venous blood in the cephalothorax. The veins here are simple interorganal lacunæ, without appreciable walls, into which the arteries discharge themselves. On examining the cephalothorax from its ventral surface, we soon recognize a very regular and very elegant system of venous currents, situated immediately beneath the chitinous layer. These sternal currents are almost exactly rectilinear, and travel in channels existing between the muscles of the sternum. We may distinguish a median channel, a la-

cuna giving origin to ten lateral or transverse channels arranged in pairs and starting from the median channel at more and more open angles in proportion as they approach the anterior margin of the animal. At the point of junction with each lateral channel the median channel undergoes an enlargement, from the bottom of which blood-corpuscles are seen emerging from the deeper parts. These corpuscles continue their course to right and left in the lateral channels, or forward in the median one as far as the lower lip, where they also throw themselves into lateral channels. Those corpuscles only which emerge from that enlargement of the median channel corresponding to the origin of the hindmost pair of lateral channels, continue their course in great part from before backwards in the posterior part of the median channel. They then traverse the abdominal peduncle, and throw themselves into the sinus of the base of the abdomen.

The blood which passes from the median into the lateral channels reaches the sides of the cephalothorax, where it unites with the currents returning from the legs in a subcutaneous lacuna occupying the whole lateral margin of the cephalothorax. In this lacuna the blood moves from before backwards; it arrives at the abdominal peduncle, where it empties itself, with the blood of the median channel, into the sinus of the base of the abdomen.

The lateral channels of the sternum do not, however, receive blood only from the median channel; at certain distances they themselves present enlarged spaces, from the bottom of which corpuscles are seen emerging, which come from still more deeply seated regions. These corpuscles continue their course with the blood coming from the median channel.

The enlarged spaces to which I have just adverted in the median and lateral channels establish a communication between these channels and more deeply seated lacunæ. The latter exist between the muscular masses which are bounded at the surface by the channels themselves; this is so true, that the interstices of communication are in part temporary. They are sometimes seen to close whilst others open beside them. In all cases their diameter varies continually, according to the movements of the animal. These lacunæ receive their blood from the sternal arteries, which open into them without any ramification.

The cephalothorax, examined from its dorsal surface, presents a less complex venous system. The eyes are bathed posteriorly by a lacuna which receives its blood from the ophthalmic arteries and conducts it into the lacunæ of the sides of the thorax already mentioned. Besides these, a subcutaneous channel (the *median tergal channel*) conveys the blood in a direct line to the abdominal peduncle. This channel receives its blood in part

from the ophthalmic lacuna, but chiefly from deep-seated median lacunæ; it becomes enlarged momentarily at one place or another, and it is at these points that the blood-corpuscles emerge from the depths. The blood is poured out into these median lacunæ by the inner and ascending branch of the artery of the protognath.

To complete this picture of the circulation in the *Lycosæ*, it now only remains for me to describe the course of the blood in the legs. The pedal arteries and the artery of the deutognath above mentioned are easily seen penetrating into the extremities. Each artery has its distinct walls and its regular pulsations, and we may trace it readily through the coxopodite and the basipodite to the middle of the mesopodite. Beyond this point I have never succeeded in recognizing either its walls or its pulsations. At the first glance, the arterial blood in the following joints seems to move only in intermuscular lacunæ. It appears to be in immediate juxtaposition with the venous blood moving in the opposite direction, although the two currents never seem to interfere with one another. The artery, as long as it has proper walls, occupies the centre of the leg, and is bathed on all sides by the venous blood. But beyond the middle of the mesopodite the arterial current occupies the side of flexion, and the venous current that of extension.

It is soon seen that only a small part of the blood conveyed into the leg by the artery finds its way to the extremity of the limb. The greater part of the blood-corpuscles pass into the venous current without penetrating so far into the foot. Moreover a careful examination quickly shows that the passage of the blood-globules from the arterial into the venous current occurs at perfectly determinate points. These are five in number, and present themselves in the form of circular, or, rather, oval spots, when the limb is examined either on the side of flexion or extension. The first is situated close to the peripheral margin of the mesopodite; the second occupies a precisely similar position in the carpopodite; the third is placed in the propodite, but at a rather greater distance from its peripheral extremity; the fourth belongs to the first dactylopodite, but is still further removed from the peripheral margin of that joint; and the fifth is placed nearly in the middle of the second dactylopodite. These clear spots, with their outlines perfectly distinct and free, are openings in a membrane which separates the arterial from the venous current. If we pay particular attention to one of these apertures—for example, that in the propodite, at the same time noting the mode in which the arterial current behaves at this point, we see that part of the blood-corpuscles continue their course directly to pass into the dactylopodite, but that some of

them, on arriving at the level of the orifice, get into it, pass into the venous current, and return with it in a direction opposite to that which they previously followed. The same thing takes place at each of the other orifices.

These arterio-venous orifices of the legs are exactly of the diameter of the blood-corpuscles. Some of the latter even traverse them with difficulty; they are seen suddenly arrested at their passage into the aperture, which they entirely obliterate; they appear to oscillate for some time in the membranous frame that embraces them, and then, the obstacle being all at once surmounted, they pass quickly into the venous current.

It is natural to inquire what is the nature of the membrane in which the arterio-venous orifices are pierced. I have never been able to recognize in it anything more than a simple amorphous membrane—a delicate partition which divides the calibre of the leg into two parallel cavities. The arrangement here would therefore be perfectly similar to that which I have elsewhere described in the extremities of the Læmodipoda*; in this case the pedal artery would discharge itself into the arterial cavity towards the middle of the mesopodite. There may, however, be another interpretation: the artery may penetrate to the extremity of the limb, as is usually supposed; and in this case the orifices which I have described would be pierced in the wall of this vessel. If I do not adopt this hypothesis, it is because I have never perceived either the walls or the pulsations of the arteries beyond the middle of the mesopodite. The carpopodite and the basipodite, in which the artery is distinct, do not appear to present any arterio-venous orifice.

I have examined comparatively the circulation in the legs of *Pholcus phalangioïdes* in nearly adult individuals. The relations of the arterial and venous currents are the same as in the *Lycosæ*. Unfortunately the transparency of these limbs, great as it is, is not sufficient to permit the recognition of the arterio-venous orifices. I can only say that in these Spiders the pedal artery appeared to me to be prolonged at least to the extremity of the mesopodite—that is to say, further than in the *Lycosæ*.

Such is the circulation of the blood in the Spiders of the genus *Lycosa*: it is essentially lacunar, as Dugès and Blanchard have correctly perceived. Recently, it is true, the latter has claimed for the Arachnida a far more complex circulatory system than he did at first. In his 'Organisation du Règne Animal' he figures especially an unexpected abundance of vascular networks in all the tissues of the Arachnida. Venous ramifications are supposed to receive the blood from these capillary nets, and to pour it into the interorganal lacunæ. I venture to affirm

* Beobachtungen, p. 101.

that these networks do not exist either as vessels or as lacunæ. Nothing can be more incorrect, for example, than the reticulations figured by M. Blanchard in the interior of the muscles, especially in the muscles of the legs. These muscles are certainly bathed by the blood of the lacunæ, but not a single blood-globule ever penetrates between the fibres of a muscle. It is possible, I readily admit, that in the adult Spiders the circulatory system may be a little more complex than in the young individuals which have not yet undergone their first change; but this increased complication certainly does not go so far as to cause the appearance of reticulations within the organs. Of this we may convince ourselves by the examination of the circulation in the legs of nearly adult *Pholci*. In these limbs it is easy to see that there exists only a single arterial current and a single venous current, without any ramification.

IV.—*Diagnoses of new Forms of Mollusca from the Vancouver District.* By Philip P. Carpenter, B.A., Ph.D.

[Concluded from vol. xiv. p. 429.]

38. ?*Assiminea subrotundata.*

?*A.* testa haud parva, lævi, tenui, fusco-olivacea; anfr. nucl. ?...(decollatis); norm. v., rapide augentibus, subrotundatis; marginibus spiræ rectis, suturis valde impressis; basi rotundata, haud umbilicata; apertura rotundato-ovali, intus fuscescente; peritremate continuo; labro acuto; labio parum calloso; columella arcuata. Long. ·28, long. spir. ·13, lat. ·2, div. 65°.

Hab. Neeah Bay; one specimen among *Lacunæ* (*Swan*).

May prove to be a large *Hydrobia*.

39. ?*Paludinella castanea.*

?*P.* testa compacta, solidiore, fusco-castanea, marginibus spiræ rectioribus; rugulosa, lineis distantibus spiralibus irregulariter insculpta; anfr. nucleosis ?.... (detritis), vertice late mamillato; norm. iv., rapidius augentibus, tumidioribus, suturis satis impressis; basi regulariter excurvata, vix rimata; apertura suborbicularí, haud continua; labro acuto; labio supra parietem obsoleto, supra columellam arcuatam intus calloso: operculo, anfr. iv. haud rapide augentibus. Long. ·21, long. spir. ·09, lat. ·17, div. 70°.

Hab. Neeah Bay; one specimen among *Lacunæ* (*Swan*).

May be an aberrant *Assiminea*.

40. *Mangelia crebricostata.*

M. testa tereti, rufo-fusca, albo zonata; anfr. nucl. ?... (decollatis); norm. v. elongatis, subrotundatis, suturis impressis; costis radi-